

METHOD OF ECHO CANCELLATION AND EQUIPMENT OF ECHO CANCELLATION

BACKGROUND OF THE INVENTION

5 (Field of the Invention)

The present invention relates to a method for canceling an echo and equipment for canceling the same, and in particular, to the method and equipment for canceling a leaked voice signal caused when a receiving voice signal leaking in part into a transmitting voice signal in
10 communication systems such as a telephone communication system.

(Description of Related Art)

In voice networks such a telephone communication system, if a receiving signal is partly leaked into a transmitting signal, the leaked signal causes an echo. The echo is attributable to, for example, a
15 hybrid circuit used for conversion between a four-wire circuit and a two-wire circuit and an acoustic feedback occurring at an end user's terminal. In networks, the echo combined with a delay in communication deteriorates acoustic quality. Thus, in general, voice transmission systems, in which a voice signal is set up into an ATM
20 (Asynchronous Transfer Mode) cell or IP (Internet Protocol) packet, has an echo cancellation equipment to avoid voice quality from being deteriorated.

This kind of conventional echo cancellation equipment is disclosed by, for example, Japanese Patent Laid-open publication No.
25 8-130497. In this echo cancellation system, it is determined whether

the network is in a single talk state or in a double talk state. The single talk state shows that a voice signal is transmitted through only a receiving line, while the double talk state shows that voice signals are transmitted through both transmitting line and receiving line.

- 5 According to the echo cancellation equipment disclosed by the publication, characters of an echo-routed path are determined only during the single talk state.

- 10 In the case of the foregoing echo cancellation equipment, a plurality of parameters are used to distinguish the single talk state from the double talk state. However, some parameters depend on the absolute level of a transmitting input voice signal passing through the echo cancellation equipment. Depending on design of levels in a network and characteristics of a hybrid circuit that might cause an echo, the network tends to be determined into either the double talk
- 15 state or the single talk state in an erroneous manner.

SUMMARY OF THE INVENTION

- 20 The present invention has been made to overcome the above difficulty, and an object of the present invention is to provide an echo cancellation method and echo cancellation equipment capable of properly canceling an echo at any time, even when a voice signal sending through a transmitting line changes in its signal level due to design of signal levels in a network and characteristics of a hybrid circuit.

- 25 According to one aspect of the present invention, there is

provided a method for canceling an echo caused by a voice signal leaking in part from a voice signal passing through a receiving line into a transmitting line, the method comprising the steps of: limiting a level of the voice signal passing through the transmitting line to a level falling
5 in a predetermined range before the leaked voice signal is cancelled; canceling the leaked voice signal included in the voice signal passing through the transmitting line; and restoring, to an original level of the voice signal obtained before the cancellation of the leaked voice signal, a level of a voice signal undergoing the cancellation of the leaked voice
10 signal and passing through the transmitting line. Accordingly, the voice signal level on the transmitting line changes due to various factors, such as design of levels for a network or characteristics of a hybrid circuit that might cause an echo, it is possible to have the echo cancellation performed within an appropriate range of voice signal levels.
15 Therefore, the echo cancellation is always done in a proper way.

It is preferred that the above method further comprises the steps of: determining whether or not either one of facsimile communication and communication on modems through the transmitting line is detected; and if either one of facsimile communication and
20 communication on modems is detected, stopping the cancellation of the leaked voice signal, the limitation of the level of the voice signal, and the restoration of the level of the voice signal. As a result, influences of the level adjustment on facsimile communication or communication on modems can be avoided.

25 According to a further aspect of the present invention, there is

provided an echo cancellation equipment having an echo canceller canceling an echo caused by a voice signal leaking in part from a voice signal passing through a receiving line into a transmitting line, comprising: echo-canceller input level adjusting means for limiting, to a value falling in a predetermined range, a level of the voice signal passing through the transmitting line to the echo canceller; and echo-canceller output level adjusting means for restoring, to an original level of the voice signal limited by the echo-canceller input level adjusting means, a level of a voice signal outputted from the echo canceller. Accordingly, the voice signal level on the transmitting line changes due to various factors, such as design of levels for a network or characteristics of a hybrid circuit that might cause an echo, it is possible to make the echo cancellation operate within an appropriate range of voice signal levels. Therefore, the echo cancellation is always done in a proper way.

Preferably, the above echo cancellation equipment further comprises determining means for determining whether or not either one of facsimile communication and communication on modems through the transmitting line is detected; and stopping means for stopping, if the determining means determines that either one of facsimile communication and communication on modems is detected, a canceling operation of the echo canceller, a level limiting operation of the echo-canceller input level adjusting means, and a level restoring operation of the echo-canceller output level adjusting means. As a result, influences of the level adjustment on facsimile communication or communication on modems can be avoided.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing:

Fig. 1 is a block diagram showing the configuration of an
embodiment of echo cancellation equipment according to the present
invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment according to the present invention will now be
described in detail with reference to the accompanying drawing.

Fig. 1 is a block diagram showing the configuration of an
embodiment of echo cancellation equipment according to the present
invention.

As shown therein, the echo cancellation equipment 1 is
connected to both of a transmitting line and a receiving line so as to
form a four-terminal network. In the echo cancellation equipment 1,
input and output terminals of a voice signal in the receiving line are
connected to each other, and this receiving voice line is connected to an
input terminal of an echo canceller 2, in which a receiving voice signal
is inputted into the echo canceller 2 through the input terminal.

A transmitting-voice-signal input terminal of the echo canceller 2
is coupled to a transmitting-voice-signal input terminal of the echo
cancellation equipment 1 via an echo-canceller input level adjusting
means 3. A transmitting-voice-signal output terminal of the echo
canceller 2 is coupled to a transmitting-voice-signal output terminal of

the echo cancellation equipment 1 via an echo-canceller output level adjusting means 4.

A facsimile (FAX)/modem detecting means 5 is electrically connected to the transmitting-voice-signal input terminal of the echo cancellation equipment 1. Output terminals of the detecting means 5 are connected to a control input terminal of each of the echo canceller 2, echo-canceller input level adjusting means 3, and echo-canceller output level adjusting means 4.

The echo canceller 2 is configured so that an echo, which is a receiving output voice signal combined into a transmitting input voice signal, is cancelled by using the receiving output voice signal.

The echo-canceller input level adjusting means 3 is configured so as to adjust in the level a transmitting input voice signal transmitted to this echo cancellation equipment 1. According to a network employing the echo cancellation equipment 1, a constant amount of level adjustment is previously set to the echo-canceller input level adjusting means 3. The level adjustment amount is properly determined beforehand. Specifically, in a previous inspection carried out for applying the echo cancellation equipment 1 to a certain network, an amount of level adjustment to allow the echo canceller 2 to operate well is obtained through tests. This level adjustment amount is then set as a fixed value.

The echo-canceller output level adjusting means 4 has a configuration that is able to adjust the level of a transmitting output voice signal that has underwent the echo cancellation, then output its

adjusted signal on the transmitting line. Like the above, a constant amount of level adjustment is previously set to the echo-canceller output level adjusting means 4. The level adjustment amount is also properly determined beforehand.

5 The amounts of level adjustment used by both echo-canceller input level adjusting means 3 and echo-canceller output level adjusting means 4 could be specified independently of each other. However, for designing a level diagram for a network, it is normal that levels at the echo canceller are kept unchanged, and instead, levels are adjusted at
10 other network devices.

 The present embodiment also employs the above general technique. In other words, the amounts of level adjustment are specified so that a reduced level by the echo-canceller input level adjusting means 3 is raised up to its original input level by the
15 echo-canceller output level adjusting means 4. This keeps the same level between the transmitting input voice signal and the transmitting output voice signal, while the level of only the transmitting input voice signal to the echo canceller 2 can be adjusted. This way of level adjustment eliminates the necessity of re-adjusting a level diagram
20 already set to other network devices, even in the case that the echo cancellation equipment 1 is additionally installed into existing networks, thus raising the versatility of the echo cancellation equipment 1.

 The FAX/modem detecting means 5 detects, from the transmitting input voice signal, a signal involved with facsimile
25 communication or communication on modems has a configuration of

controlling the echo canceller 2, echo-canceller input level adjusting means 3, and echo-canceller output level adjusting means 4.

The entire operation of the thus-configured echo cancellation equipment will now be described.

5 Due to a hybrid circuit used for conversion between a four-wire circuit and a two-wire circuit, an acoustic feedback at an end user's terminal, or other factors, the receiving output voice signal from the echo cancellation equipment 1 leaks in part into the transmitting input voice signal, thus causing an echo. This echo is supplied to the echo
10 canceller 2. The echo canceller 2 estimates an impulse response to a route of the echo from both of the receiving output voice signal and transmitting input voice signal, convolutes both of the receiving output voice signal and the impulse response to produce a pseudo echo, and subtracts the pseudo echo from the transmitting input voice signal.
15 Thus, the echo is canceled from the transmitting input voice signal.

For estimating the impulse response of the route of the echo, the echo canceller 2 cannot estimate the impulse response with precision under the double talk state, because disturbance signals are contained in the transmitting input voice signal under such double talk state. To
20 avoid this inconvenience, the echo canceller 2 determines if the network is in the single talk state or double talk state on the basis of both of the receiving input voice signal and the transmitting input voice signal. And the echo canceller 2 estimates the impulse response of the route of the echo under only the single talk state, but the echo canceller 2 stops
25 to estimate such impulse response under the double talk state.

Though a plurality of parameters are used for determining if a network is under the single talk state or the double talk state, some parameters depend on an absolute level of a transmitting input voice signal to the echo canceller 2. Depending on designed states of levels
5 for a network, characteristics of a hybrid circuit that might be attributable to an echo, and/or others, there are some cases in which an absolute level of the transmitting input voice signal is relatively high. In such a case, there is a tendency that the network is determined to be under the double talk state, even though the impulse response to the
10 route of an echo could be estimated with precision. If determined to be under the double talk state in such a case, an amount of canceling an echo and a convergence time for cancellation of an echo are deteriorated in precision.

In such a case, according to the present embodiment, the
15 transmitting input voice signal to the echo cancellation equipment 1 is reduced in the level down to a level falling in a predetermined range by the echo-canceller input level adjusting means 3, then sent to the echo canceller 2. As a result, the level of the transmitting input voice signal to the echo canceller 2 is given as a level falling in a range that allows
20 the echo canceller 2 to determine the single talk state or the double talk state with accuracy.

Additionally, the echo-canceller output level adjusting means 4
raise the signal level by an amount reduced by the echo-canceller input level adjusting means 3. A combination of the adjusting means 3 and
25 4 makes it possible that the levels of the transmitting input voice signal

and transmitting output voice signal to and from the echo cancellation equipment 1 are kept unchanged, but only the transmitting input voice signal to the echo canceller 2 is adjusted in the level.

On the other hand, the FAX/modem detecting means 5 monitors the transmitting input voice signal to the echo cancellation equipment 1. If detecting facsimile communication or communication on modems during the monitoring, the detecting means 5 makes the echo canceller 2 stop its operation, makes both echo-canceller input level adjusting means 3 and echo-canceller output level adjusting means 4 stop their level adjustment operations. This stop control permits the transmitting input voice signal to be outputted as a transmitting output voice signal without any processing performed on the signal. Thus influences of the level adjustment on the facsimile communication or communication with modems can be avoided.

The foregoing has been described about an embodiment in which the transmitting input voice signal inputted to the echo cancellation equipment 1 is relatively higher in the level, depending on various factors, such as design of levels for a network or characteristics of a hybrid circuit which might cause an echo. Alternatively, the echo cancellation technique can be applied to an embodiment in which the transmitting input voice signal inputted to the echo cancellation equipment is relatively lower in the level. In such a case, the transmitting input voice signal to the echo cancellation apparatus 1 is raised in the level by the echo-canceller input level adjusting means 3 up to a level residing within a certain range, then sent to the echo

canceller 2. In contrast, the signal level is reduced by the echo-canceller output level adjusting means 4 by an amount of level increased by the echo-canceller input level adjusting means 3, so that the signal is kept to its original level.

5 As can be understood from the above, the voice signal level on the transmitting line changes due to various factors, such as design of levels for a network or characteristics of a hybrid circuit that might cause an echo, it is possible to make the echo canceller operate within an appropriate range of voice signal levels. Therefore, the echo
10 cancellation equipment applied to various types of network is able to provide the advantage that a satisfactory characteristic of echo cancellation can be obtained.

The present invention is not limited to the above embodiment, and can be carried out in further various modes within the gist of the
15 present invention indicated by the appended claims.